Applicants submit that all of the pending claims are patentable over the prior art. Each of the independent claims 1, 17, and 36, are limited to methods comprising etching an amorphous carbon layer while forming a hardmask in a photoresist layer. Such a concept is not disclosed or suggested in any of the references relied on by the Examiner.

Claims 1-7, 12-14, and 36-42 are rejected under 35 U.S.C. § 103(a) as being unpatentable over *Babich et al.* (5,830,332) in view of *Lin et al.* (6.087,064). The Examiner asserts that it would have been obvious to one of ordinary skill in the art to prepare a device by the method of *Babich* using the silicon containing photoresist material of *Lin*. Applicants respectfully respond to this rejection.

Babich teaches a method for depositing a hydrogenated amorphous carbon layer that has optical properties sufficient to form UV and DUV attenuated phase shift masks. (*see* Column 2, Lines 38 – 45) The method includes depositing the hydrogenated amorphous carbon layer via a sputter deposition technique, and then patterning and etching the amorphous carbon layer via laser radiation or a reactive ion etching (RIE) process. (*see* Column 7, Lines 5 – 18) Once the amorphous carbon layer is patterned, the resist layer is stripped off the amorphous carbon hard mask layer. (*See* Column 11, Line 5) The resulting amorphous carbon hard mask layer is then used as a single mask layer to pattern to etch the underlying layer.

Lin teaches a multilayer lithographic method and an associated photoresist compound. The lithographic method of *Lin* is generally described as using a photoresist compound that includes a silicon containing polymer component, an acid-sensitive crosslinking component, and a photosensitive acid generator. (*See* Column 7, Lines 58 – 65) The silicon containing polymer component portion of the photoresist is described as having a silicon content of at least about 5 wt. %, and more preferably at least about 10 wt. %. (*See* Column 10, Lines 24 – 35)

Babich and *Lin*, either alone or in combination, do not suggest or motivate depositing a silicon containing photoresist on an amorphous carbon layer or forming an in situ resist layer hard mask in an outer portion of the photoresist layer while etching through the amorphous carbon layer in a patterned region defined by the resist pattern.

Thus, *Babich* and *Lin*, either alone or in combination, do not teach, show, or suggest depositing an amorphous carbon layer on a substrate, depositing a silicon containing photoresist layer on top of the amorphous carbon layer, developing a pattern transferred into the resist layer with a photolithographic process, and forming an in situ resist layer hard mask in an outer portion of the photoresist layer while etching through the amorphous carbon layer in at least one region defined by the pattern in the resist layer, as recited in claim 1 and claims dependent thereon.

Further, *Babich* and *Lin*, either alone or in combination, do not teach, show, or suggest depositing a silicon containing photo resist layer over a material layer, wherein the material layer comprises an amorphous carbon layer, developing a pattern in the silicon containing photo resist layer, and forming a hardmask layer in the silicon containing photo resist layer while etching the material layer with an oxygen based etchant to transfer the pattern into the material layer, as recited in claim 36 and claims dependent thereon. Withdrawal of the rejection is respectfully requested.

Claims 10, 11, 16-26, and 30-35 are rejected under 35 U.S.C. § 103(a) as being unpatentable over *Babich et al.* in view of *Lin et al.* and *Mitani et al.* (6,191,463). The Examiner asserts that it would have been obvious to one of ordinary skill in the art to prepare a device by the method of *Babich* using the silicon containing photoresist material of *Lin* and adding an insulating layer of silicon oxide or silicon nitride as taught by *Mitani*. Applicants respectfully respond to this rejection.

Babich and *Lin* are described above. *Mitani* discloses an apparatus and method for forming an improved insulating film on a substrate using a CVD process to deposit a thermally insulating film, a silicon oxide layer. *Mitani* does not suggest or motivate depositing a silicon containing photoresist on an amorphous carbon layer or forming an in situ resist layer hard mask in an outer portion of the photoresist layer while etching through the amorphous carbon layer in a patterned region defined by the resist pattern.

Babich, *Lin*, and *Mitani*, either alone or in combination, do not teach, show, or suggest depositing an amorphous carbon layer on a substrate, depositing a silicon containing photoresist layer on top of the amorphous carbon layer, developing a pattern transferred into the resist layer with a photolithographic process, and forming an in situ resist layer hard mask in an outer portion of the photoresist layer while etching through

the amorphous carbon layer in at least one region defined by the pattern in the resist layer, as recited in claim 1 and claims dependent thereon.

Babich, *Lin*, and *Mitani*, either alone or in combination, do not teach, show, or suggest depositing an amorphous carbon layer on the material layer, depositing a photoresist layer on top of the amorphous carbon layer, developing a resist pattern transferred into the photoresist layer, forming an in situ resist layer hard mask in an outer portion of the photoresist layer while etching through the amorphous carbon layer in a patterned region defined by the resist pattern, and etching through the material layer under the amorphous carbon layer using the patterned region etched into the amorphous carbon layer and the resist pattern, as recited in claim 17 and claims dependent thereon. Withdrawal of the rejection is respectfully requested.

Claims 8, 9, 43, and 44 are rejected under 35 U.S.C. § 103(a) as being unpatentable over *Babich et al.* in view of *Lin et al.* and *Yang et al.* (6,165,695). The Examiner asserts that it would have been obvious to one of ordinary skill in the art to prepare a device by the method of *Babich* using the silicon containing photoresist material of *Lin* and using a photoresist layer having any thickness taught by *Yang*. Applicants respectfully respond to this rejection.

Babich and *Lin* are described above. *Yang* discloses the thicknesses of ultra-thin photoresist layers disposed on an amorphous silicon layer. The resist layer is disclosed as having a thickness within the range of 50 angstroms to 2000 angstroms (Column 3, lines 25 – 26). *Yang* does not suggest or motivate depositing a silicon containing photoresist on an amorphous carbon layer or forming an in situ resist layer hard mask in an outer portion of the photoresist layer while etching through the amorphous carbon layer in a patterned region defined by the resist pattern.

Thus, the combination of *Babich, Lin*, and *Yang*, do not teach, show, or suggest depositing an amorphous carbon layer on a substrate, depositing a silicon containing photoresist layer on top of the amorphous carbon layer, developing a pattern transferred into the resist layer with a photolithographic process, and forming an in situ resist layer hard mask in an outer portion of the photoresist layer while etching through the amorphous carbon layer in at least one region defined by the pattern in the resist layer, as recited in claim 1 and claims dependent thereon.

Further, the combination of *Babich, Lin*, and *Yang*, do not teach, show, or suggest depositing a silicon containing photo resist layer over a material layer, wherein the material layer comprises an amorphous carbon layer, developing a pattern in the silicon containing photo resist layer, and forming a hardmask layer in the silicon containing photo resist layer while etching the material layer with an oxygen based etchant to transfer the pattern into the material layer, as recited in claim 36 and claims dependent thereon. Withdrawal of the rejection is respectfully requested.

Claims 27 and 28 are rejected under 35 U.S.C. 35 § 103(a) as being unpatentable over *Babich et al.* in view of *Lin et al.*, *Mitani et al.* and in further view of *Yang et al.* The Examiner asserts that it would have been obvious to one of ordinary skill in the art to prepare a device by the method of *Babich* using the silicon containing photoresist material of *Lin* and adding an insulating layer of silicon oxide or silicon nitride as taught by *Mitani*. Applicants respectfully respond to this rejection.

Babich, Lin, Mitani, and *Yang*, are described above, and either alone or in combination, do not teach, show, or suggest depositing an amorphous carbon layer on the material layer, depositing a photoresist layer on top of the amorphous carbon layer, developing a resist pattern transferred into the photoresist layer, forming an in situ resist layer hard mask in an outer portion of the photoresist layer while etching through the amorphous carbon layer in a patterned region defined by the resist pattern, and etching through the material layer under the amorphous carbon layer using the patterned region etched into the amorphous carbon layer and the resist pattern, as recited in claim 17 and claims dependent thereon.

Claim 15 is rejected under 35 U.S.C. § 103(a) as being unpatentable over *Babich et al.* in view of *Lin et al.*, in further view of *Sobczak* (4,576,834). The Examiner asserts that it would have been obvious to one of ordinary skill in the art to prepare a device by the method of *Babich* using the silicon containing photoresist material of *Lin* and etching the photoresist masking layer while etching the underlying layers as taught by *Sobczak*. Applicants respectfully respond to this rejection.

Babich and *Lin* are described above. *Sobczak* discloses a semiconductor stack fabrication process wherein an RIE process is used to etch an underlying layer masked by a photoresist layer. The RIE process is disclosed as etching the underlying layer

while also removing a portion of the photoresist layer. *Sobczak* does not suggest or motivate depositing a silicon containing photoresist on an amorphous carbon layer or forming an in situ resist layer hard mask in an outer portion of the photoresist layer while etching through the amorphous carbon layer in a patterned region defined by the resist pattern.

Babich, *Lin*, and *Sobczak,* either alone or in combination, do not teach, show, or suggest depositing an amorphous carbon layer on a substrate, depositing a silicon containing photoresist layer on top of the amorphous carbon layer, developing a pattern transferred into the resist layer with a photolithographic process, and forming an in situ resist layer hard mask in an outer portion of the photoresist layer while etching through the amorphous carbon layer in at least one region defined by the pattern in the resist layer, as recited in claim 1 and claims dependent thereon. Withdrawal of the rejection is respectfully requested.

Claim 29 is rejected under 35 U.S.C § 103(a) as being unpatentable over *Babich, et al.* in view of *Lin, et al.* and *Mitani, et al.* in further view of *Sobczak.* The Examiner asserts that it would have been obvious to one of ordinary skill in the art to prepare a device by the method of *Babich* using the silicon containing photoresist material of *Lin* and adding an insulating layer of silicon oxide or silicon nitride as taught by *Mitani* and etching the photoresist masking layer while etching the underlying layers as taught by *Sobczak*. Applicants respectfully respond to this rejection.

Babich, Lin, Mitani, and *Sobczak* are described above, and, either alone or in combination, do not teach, show, or suggest depositing an amorphous carbon layer on the material layer, depositing a photoresist layer on top of the amorphous carbon layer, developing a resist pattern transferred into the photoresist layer, forming an in situ resist layer hard mask in an outer portion of the photoresist layer while etching through the amorphous carbon layer in a patterned region defined by the resist pattern, and etching through the material layer under the amorphous carbon layer using the patterned region etched into the amorphous carbon layer and the resist pattern, as recited in claim 17 and claims dependent thereon.

The prior art made of record is noted. However, it is believed that the secondary references are no more pertinent to the Applicants' disclosure than the primary

references cited in the office action. Therefore, it is believed that a detailed discussion of the secondary references is not deemed necessary for a full and complete response to this office action. Accordingly, allowance of the claims is respectfully requested.

In conclusion, the references cited by the Examiner, neither alone nor in combination, teach, show, or suggest the method or apparatus of the present invention. Having addressed all issues set out in the office action, Applicants respectfully submit that the claims are in condition for allowance and respectfully request that the claims be allowed.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

1. (Amended) A method for forming a patterned amorphous carbon layer in a multilayer stack, comprising:

depositing an amorphous carbon layer on a substrate;

depositing a silicon containing photoresist layer on top of the amorphous carbon layer;

developing a pattern transferred into the resist layer with a photolithographic process;

[etching through the amorphous carbon layer in at least one region defined by the pattern in the resist layer;] and

forming an in situ resist layer hard mask in an outer portion of the photoresist layer while etching through the amorphous carbon layer in at least one region defined by the pattern in the resist layer.

17. (Amended) A method for patterning a material layer in a multilayer stack, comprising:

depositing an amorphous carbon layer on the material layer;

depositing a photoresist layer on top of the amorphous carbon layer;

developing a resist pattern transferred into the photoresist layer;

[etching through the amorphous carbon layer in a patterned region defined by the resist pattern;]

forming an in situ resist layer hard mask in an outer portion of the photoresist layer [during the etching process for the amorphous carbon layer] while etching through the amorphous carbon layer in a patterned region defined by the resist pattern; and

etching through the material layer under the amorphous carbon layer using the patterned region etched into the amorphous carbon layer and the resist pattern.

36. (Amended) A method for forming a hardmask in a resist layer, comprising:

depositing a silicon containing photo resist layer over a material layer, wherein the material layer comprises an amorphous carbon layer;

developing a pattern in the silicon containing photo resist layer;

[etching the material layer with an oxygen based etchant to transfer the pattern into the material layer;] and

forming a hardmask layer in the silicon containing photo resist layer [during the etching process] <u>while etching the material layer with an oxygen based etchant to transfer the pattern into the material layer</u>.